GRADE 12 DIPLOMA EXAMINATION

Chemistry 30

January 1985

Alberta
EDUCATION

GRADE 12 DIPLOMA EXAMINATION
CHEMISTRY 30

DESCRIPTION

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A chemistry data booklet is provided for your reference. Approved calculators may be used.

GENERAL INSTRUCTIONS

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. USE AN HB PENCIL ONLY.

Example **Answer Sheet**

This examination is for the subject area of

A	B	C	D
●	②	③	④

A. Chemistry
B. Biology
C. Physics
D. Mathematics

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

JANUARY 1985

PART A

INSTRUCTIONS

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B

DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD TO DO SO BY THE PRESIDING EXAMINER.

1. Which statement describes temperature and potential energy conditions during a phase change?

   A. Both temperature and potential energy change
   B. Both temperature and potential energy remain constant
   C. Temperature remains constant and potential energy changes
   D. Temperature changes and potential energy remains constant

2. Under standard state conditions, the molar heat of formation for a compound is

   A. the difference between the heats of formation of the elements from which the compound is formed
   B. the energy consumed or released when one mole of a substance is formed from its elements
   C. the sum of the heats of formation of the elements from which the compound is formed
   D. zero for a compound in its naturally occurring form

3. Consider the equation $2Li_{(s)} + Cl_{2(g)} \longrightarrow 2LiCl_{(s)} + 820$ kJ. The molar heat of formation of $LiCl_{(s)}$ is

   A. +820 kJ/mol
   B. +410 kJ/mol
   C. −410 kJ/mol
   D. −820 kJ/mol

Use the following information to answer question 4.

A student dissolves some $NaCl_{(s)}$ in a beaker of water. This process is represented by the equation $NaCl_{(s)} \longrightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$.

Temperatures are measured and recorded:

initial temperature of the water = 21.2°C

final temperature of the resulting solution = 19.6°C

4. Based on the data, which conclusion is justified?

   A. $NaCl_{(s)} \longrightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$ has a negative ΔH value.

   B. $NaCl_{(s)}$ dissolving in water is an exothermic reaction.

   C. The potential energy of 1 mol of $NaCl_{(s)}$ is lower than the combined potential energy of 1 mol of $Na^{+}_{(aq)}$ and $Cl^{-}_{(aq)}$.

   D. The potential energy of 1 mol of $NaCl_{(s)}$ is higher than the combined potential energy of 1 mol of $Na^{+}_{(aq)}$ and $Cl^{-}_{(aq)}$.

5. Consider the equation $2Hg_{(l)} + F_{2(g)} \longrightarrow 2HgF_{(g)}$ $\Delta H = +117$ kJ. In this reaction

A. 117 kJ of heat are absorbed per mole of $HgF_{(g)}$
B. 117 kJ of heat are released per mole of $HgF_{(g)}$
C. 58.5 kJ of heat are absorbed per mole of $HgF_{(g)}$
D. 58.5 kJ of heat are released per mole of $HgF_{(g)}$

6. The reaction that would release the MOST energy per mole is

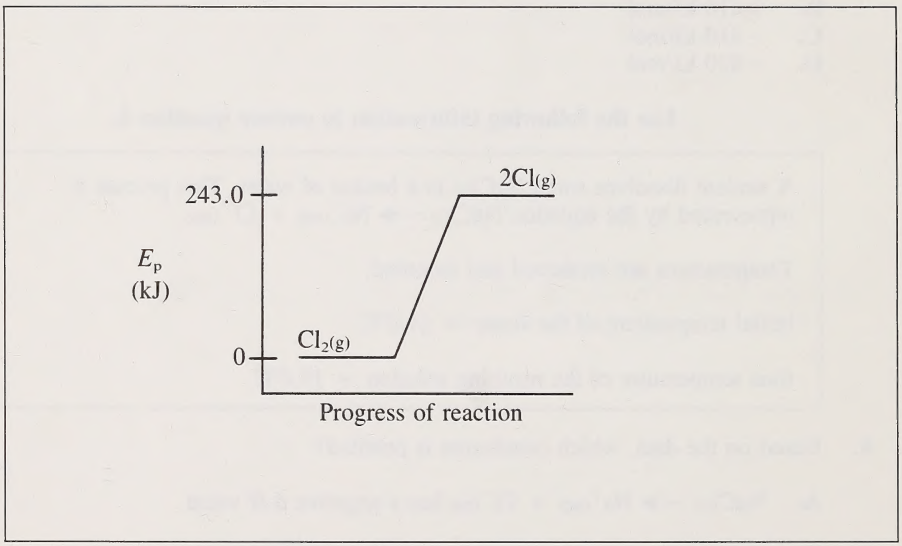
A. $H_{2(g)} \longrightarrow H_{2(l)}$

B. $H^+_{(g)} + e^- \longrightarrow H_{(g)}$

C. $H_{(g)} + H_{(g)} \longrightarrow H_{2(g)}$

D. ${}^{1}_{1}H + {}^{15}_{7}N \longrightarrow {}^{12}_{6}C + {}^{4}_{2}He$

Use the following information to answer question 7.



7. The diagram represents a heat change of

A. 243.0 kJ released
B. 121.5 kJ released
C. 121.5 kJ absorbed
D. 243.0 kJ absorbed

Use the following information to answer question 8.

I	$3C_{(s)} + 3H_{2(g)} \longrightarrow C_2H_5COOH_{(l)} + Energy_1$
II	${}^{2}_{1}H + {}^{3}_{1}H \longrightarrow {}^{4}_{2}He + {}^{1}_{0}n + Energy_2$
III	$H_2O_{(g)} \longrightarrow H_2O_{(l)} + Energy_3$
IV	$I_{2(g)} \longrightarrow I_{2(s)} + Energy_4$

8. A CORRECT statement regarding the above reactions is:

A. Reaction III is a sublimation reaction.
B. $Energy_4$ is most likely greater than $Energy_1$.
C. $Energy_3$ is most likely less than either $Energy_1$ or $Energy_2$.
D. Reaction I involves the breaking and making of proton-neutron bonds.

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9. The heat of formation of substance Z is $+50.3$ kJ/mol, and of substance T is -33.5 kJ/mol. For the reaction Z $\longrightarrow$ T, ΔH would be

A. -83.8 kJ
B. -16.8 kJ
C. $+16.8$ kJ
D. $+83.8$ kJ

10. The ΔH for the reaction $CaO_{(s)} + CO_{2(g)} \longrightarrow CaCO_{3(s)}$ is

A. -1206.9 kJ
B. -177.9 kJ
C. $+177.9$ kJ
D. $+1206.9$ kJ

11. If 0.838 kJ is absorbed by 200 g of liquid water, the temperature increase is

A. 100°C
B. 10°C
C. 1°C
D. 0.1°C

12. When 5.60 g of ethane, $C_2H_{6(g)}$, are burned in a calorimeter containing 802 g of water at 20.0°C, the temperature of the water increases to 97.0°C. The heat of combustion for ethane is

A. 4.62×10^1 kJ/mol
B. 2.59×10^2 kJ/mol
C. 1.39×10^3 kJ/mol
D. 1.45×10^3 kJ/mol

13. When the heat of combustion of a substance is measured by calorimetry, it is assumed that

A. as the temperature increases, the rate of reaction increases
B. the heat released per mole will depend on the amount of water in the calorimeter
C. the heat released per mole will depend on the number of moles of substance burned
D. the heat gained by the calorimeter and its contents is equal to the heat released by the substance

Use the following information to answer question 14.

$$2Y_{(s)} + \tfrac{3}{2}O_{2(g)} \longrightarrow Y_2O_{3(s)} + 2095 \text{ kJ}$$

$$2M_{(s)} + \tfrac{3}{2}O_{2(g)} \longrightarrow M_2O_{3(s)} + 419 \text{ kJ}$$

14. The heat of reaction for $2Y_{(s)} + M_2O_{3(s)} \longrightarrow 2M_{(s)} + Y_2O_{3(s)}$ is

A. −2514 kJ
B. −1676 kJ
C. +1676 kJ
D. +2514 kJ

Use the following information to answer question 15.

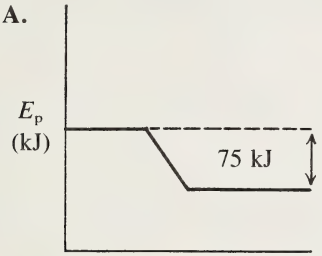
$$N_{2(g)} + \tfrac{5}{2}O_{2(g)} + 15\ kJ \longrightarrow N_2O_{5(g)}$$

$$H_{2(g)} + \tfrac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)} + 286\ kJ$$

$$\tfrac{1}{2}H_{2(g)} + \tfrac{1}{2}N_{2(g)} + \tfrac{3}{2}O_{2(g)} \longrightarrow HNO_{3(l)} + 173\ kJ$$

15. The graph that represents the reaction $N_2O_{5(g)} + H_2O_{(l)} \longrightarrow 2HNO_{3(l)}$ is

A.



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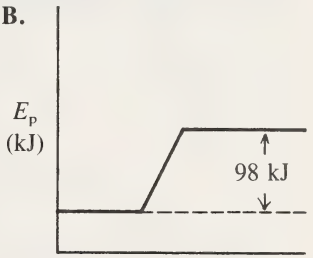

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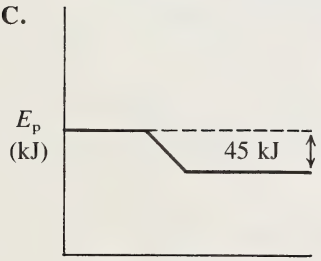
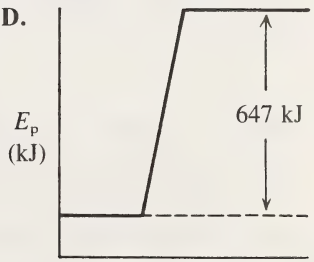


D.



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16. If $\frac{1}{2}N_{2(g)} + O_{2(g)} + 33.8\ kJ \longrightarrow NO_{2(g)}$, the heat required for the formation of 2.50 mol of $NO_{2(g)}$ is

A. 84.5 kJ
B. 67.6 kJ
C. 33.8 kJ
D. 13.5 kJ

17. How much heat is absorbed in the formation of 1.61 g of ethene, $C_2H_{4(g)}$, from elements?

A. 3.00 kJ
B. 32.5 kJ
C. 84.2 kJ
D. 522 kJ

18. How much heat is absorbed if 4.80 g of $C_{(s)}$ are consumed by the reaction $H_2O_{(g)} + C_{(s)} + 131\ kJ \longrightarrow CO_{(g)} + H_{2(g)}$?

A. 27.3 kJ
B. 52.4 kJ
C. 131 kJ
D. 327 kJ

19. One characteristic property of a strong base is that it

A. tastes sour
B. turns red litmus blue
C. reacts with magnesium metal to release hydrogen gas
D. produces a colorless solution when phenolphthalein is added

20. Which of the following is an example of acid-base neutralization?

A. $CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$

B. $H_2SO_{4(aq)} + Zn_{(s)} \longrightarrow ZnSO_{4(aq)} + H_{2(g)}$

C. $LiOH_{(aq)} + HF_{(g)} \longrightarrow LiF_{(aq)} + H_2O_{(l)}$

D. $NH^+_{4(aq)} + NO^-_{3(aq)} \longrightarrow NH_4NO_{3(s)}$

21. What is the essential difference between a 1.0 mol/L solution of a weak acid and a 1.0 mol/L solution of a strong acid?

A. The weak acid is more dilute
B. The strong acid can act as a base
C. The weak acid does not conduct electricity
D. The strong acid has more hydronium ions per litre

22. In the reaction $HSO_{4(aq)}^{-} + NH_{3(g)} \leftrightharpoons NH_{4(aq)}^{+} + SO_{4}^{2-}{}_{(aq)}$, the two bases are

A. $SO_{4}^{2-}{}_{(aq)}$ and $HSO_{4(aq)}^{-}$

B. $SO_{4}^{2-}{}_{(aq)}$ and $NH_{4(aq)}^{+}$

C. $NH_{3(g)}$ and $SO_{4}^{2-}{}_{(aq)}$

D. $NH_{3(g)}$ and $NH_{4(aq)}^{+}$

23. $HCO_{3(aq)}^{-}$ may react as an acid or a base. It is an acid in the reaction

A. $HCO_{3(aq)}^{-} + HSO_{3(aq)}^{-} \leftrightharpoons H_2CO_{3(aq)} + SO_{3}^{2-}{}_{(aq)}$

B. $HCO_{3(aq)}^{-} + H_2O_{(l)} \leftrightharpoons OH^{-}{}_{(aq)} + H_2CO_{3(aq)}$

C. $HCO_{3(aq)}^{-} + H_2O_{(l)} \leftrightharpoons H_3O^{+}{}_{(aq)} + CO_{3}^{2-}{}_{(aq)}$

D. $HCO_{3(aq)}^{-} + H_3O^{+}{}_{(aq)} \leftrightharpoons 2H_2O_{(l)} + CO_{2(aq)}$

24. In the reaction between $H_2SO_{3(aq)}$ and $SO_{3}^{2-}{}_{(aq)}$, the expected product(s) would be

A. $HSO_{3(aq)}^{-}$

B. $SO_{4}^{2-}{}_{(aq)}$

C. $H_2SO_{4(aq)}$

D. $SO_{2(g)}$ and $HSO_{4(aq)}^{-}$

Use the following information to answer question 25.

$HA_{(aq)} + B^{-}{}_{(aq)} \leftrightharpoons HB_{(aq)} + A^{-}{}_{(aq)}$ (products favored)

$HC_{(aq)} + A^{-}{}_{(aq)} \leftrightharpoons HA_{(aq)} + C^{-}{}_{(aq)}$ (products favored)

$HD_{(aq)} + C^{-}{}_{(aq)} \leftrightharpoons HC_{(aq)} + D^{-}{}_{(aq)}$ (reactants favored)

$HD_{(aq)} + B^{-}{}_{(aq)} \leftrightharpoons HB_{(aq)} + D^{-}{}_{(aq)}$ (reactants favored)

25. The acids listed in order of decreasing strength are

A. HC, HA, HB, HD
B. HC, HD, HA, HB
C. HD, HB, HA, HC
D. HA, HB, HD, HC

26. What will occur when $HOOCCOOH_{(s)}$ is added to water?

A. The pH will increase
B. The $[OH^-_{(aq)}]$ will decrease
C. Hydrogen gas will be released
D. Red litmus will turn blue in the solution

27. If the pH of egg-white is 7.8, then the hydrogen ion concentration is

A. 1.6×10^{-8} mol/L
B. 8.0×10^{-7} mol/L
C. 7.8×10^{-1} mol/L
D. 8.9×10^{-1} mol/L

Use the following information to answer question 28.

Proposed laboratory procedures:

I	add more water
II	add a strong base
III	add a strong acid
IV	remove solvent by evaporation
V	reduce volume of sample by dividing it into two equal portions

28. Which of these procedures may be used to increase the pH of a weak acid solution?

A. V only
B. I and II
C. III and IV
D. III, IV, and V

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29. If the pH of 0.1 mol/L $NaHCO_{3(aq)}$ is 8, the $[OH^-_{(aq)}]$ is

A. 10^{-13} mol/L
B. 10^{-8} mol/L
C. 10^{-6} mol/L
D. 10^{-5} mol/L

30. In which solution would phenolphthalein be pink?

A. $[OH^-_{(aq)}] = 10^{-3}$ mol/L

B. $[H_3O^+_{(aq)}] = 10^{-4}$ mol/L

C. $[H_3O^+_{(aq)}] = 10^{-6}$ mol/L

D. $[OH^-_{(aq)}] = 10^{-11}$ mol/L

31. A solution of sodium acetate, $NaCH_3COO$, turns red litmus paper blue because

A. acetate solutions are acidic
B. solid sodium acetate contains $OH^-_{(aq)}$
C. water molecules donate $H^+_{(aq)}$ to $CH_3COO^-_{(aq)}$
D. water molecules donate $OH^-_{(aq)}$ to $CH_3COO^-_{(aq)}$

32. All reactions between water solutions of strong acids and strong bases may be shown as

A. $CH_3COOH_{(aq)} + KOH_{(aq)} \longrightarrow KCH_3COO_{(aq)} + H_2O_{(l)}$

B. $HCl_{(aq)} + NaOH_{(aq)} \longrightarrow H_2O_{(l)} + NaCl_{(aq)}$

C. $H_3O^+_{(aq)} + O^{2-}_{(aq)} \longrightarrow OH^-_{(aq)} + H_2O_{(l)}$

D. $H_3O^+_{(aq)} + OH^-_{(aq)} \longrightarrow 2H_2O_{(l)}$

33. Of the following, the strongest acid listed is

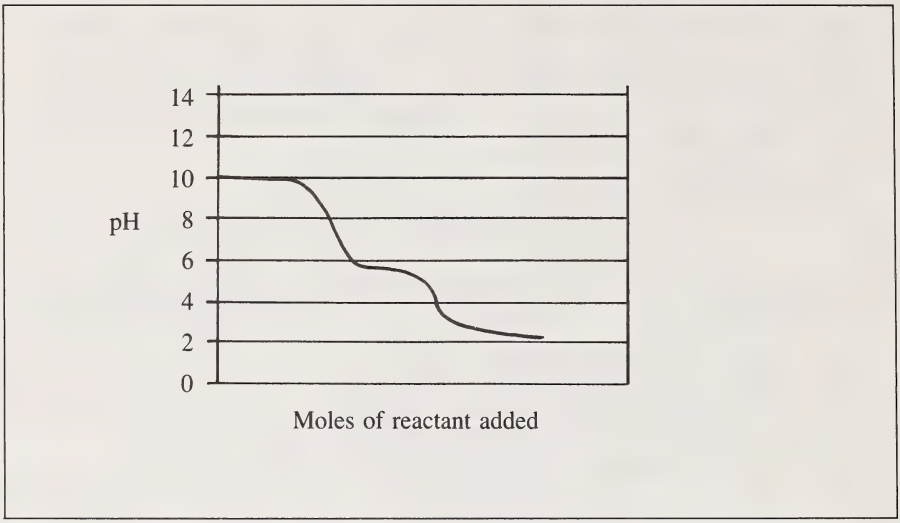
A. $H_2YO^-_{3(aq)}$

B. $HYO^{2-}_{3(aq)}$

C. $H_3YO_{3(aq)}$

D. $YO^{3-}_{3(aq)}$

Use the following information to answer question 34.

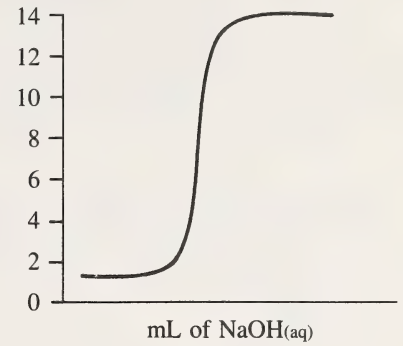


34. The indicator that would BEST show the first endpoint of the titration is

A. methyl red
B. phenol red
C. methyl orange
D. alizarin yellow

Use the following information to answer question 35.

The graph to the right represents the progressive titration of 50.0 mL of 0.10 mol/L $HCl_{(aq)}$ with 0.10 mol/L of $NaOH_{(aq)}$.



35. At the equivalence point the pH is

A. 2
B. 7
C. 12
D. 14

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36. 20.0 mL of HNO_3 solution is titrated to the endpoint with 60.0 mL of 0.600 mol/L NaOH solution. The concentration of the HNO_3 solution is

A. 2.24 mol/L
B. 1.80 mol/L
C. 1.12 mol/L
D. 0.560 mol/L

37. The volume of 0.500 mol/L HCl solution required to completely neutralize 50.0 mL of 0.100 mol/L $Ba(OH)_2$ solution is

A. 5.00 mL
B. 10.0 mL
C. 20.0 mL
D. 50.0 mL

38. An example of a reduction half-reaction is

A. $Se_{(s)} + 2H^+_{(aq)} + 2e^- \longrightarrow H_2Se_{(g)}$

B. $2Ag_{(s)} + S^{2-}_{(aq)} \longrightarrow Ag_2S_{(s)} + 2e^-$

C. $SO_{2(g)} + 2H_2O_{(l)} \longrightarrow 4H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2e^-$

D. $2Cr^{3+}_{(aq)} + 7H_2O_{(l)} \longrightarrow Cr_2O_7^{2-}{}_{(aq)} + 14H^+_{(aq)} + 6e^-$

39. The substance that does NOT act as both an oxidizing and a reducing agent is

A. $Fe^{2+}_{(aq)}$
B. $Sn^{2+}_{(aq)}$
C. $H_2O_{(l)}$
D. $Cd^{2+}_{(aq)}$

40. A spontaneous reaction occurs when chlorine gas is bubbled through a sodium bromide solution. The oxidizing agent is

A. $Cl^-_{(aq)}$
B. $Br^-_{(aq)}$
C. $Br_{2(l)}$
D. $Cl_{2(g)}$

41. The equation that represents an oxidation-reduction reaction is

A. $H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$

B. $Ni^{2+}_{(aq)} + S^{2-}_{(aq)} \longrightarrow NiS_{(s)}$

C. $Cl_{2(aq)} + H_{2(g)} \longrightarrow 2Cl^-_{(aq)} + 2H^+_{(aq)}$

D. $H^+_{(aq)} + Cl^-_{(aq)} + CH_3OH_{(aq)} \longrightarrow CH_3Cl_{(l)} + H_2O_{(l)}$

42. The greatest number of electrons would be generated by the oxidation of one mole of

A. Fe^{2+} to Fe^{3+}
B. Sn^{2+} to Sn^{4+}
C. Ca to Ca^{2+}
D. Cr to Cr^{3+}

43. $As_{(s)}$ reacts with acidified $Cr_2O_7^{2-}{}_{(aq)}$ to form $As_2O_{3(s)}$ and $Cr^{3+}{}_{(aq)}$. The balanced redox equation for this reaction is

A. $As_{(s)} + Cr_2O_7^{2-}{}_{(aq)} \longrightarrow As_2O_{3(s)} + Cr^{3+}{}_{(aq)} + 4e^-$

B. $2As_{(s)} + 2HCr_2O_{7(l)} \longrightarrow As_2O_{3(s)} + H_2O_{(l)} + 5O_{2(g)} + 4Cr_{(s)}$

C. $As_{(s)} + Cr_2O_7^{2-}{}_{(aq)} + H^+{}_{(aq)} \longrightarrow As_2O_{3(s)} + Cr^{3+}{}_{(aq)} + H_2O_{(l)}$

D. $2As_{(s)} + Cr_2O_7^{2-}{}_{(aq)} + 8H^+{}_{(aq)} \longrightarrow As_2O_{3(s)} + 2Cr^{3+}{}_{(aq)} + 4H_2O_{(l)}$

44. In an operating electrochemical cell that has chromium as the anode, 9 mol of electrons are generated. The number of moles of Cr^{3+} produced is

A. 1 mol
B. 3 mol
C. 6 mol
D. 9 mol

45. A current of 2.00 A is passed for 7.00 h through an electrolytic cell containing $MgCl_{2(l)}$. The mass of substance collected at the cathode is

A. 37.0 g
B. 18.5 g
C. 12.7 g
D. 6.35 g

46. The standard reduction potential for the half-reaction $X^{2+}{}_{(aq)} + 2e^- \longrightarrow X_{(s)}$ is -0.56 V. If $Na^+{}_{(aq)} + e^- \longrightarrow Na_{(s)}$ is assigned a value of 0.00 V, then the reduction potential for the half-reaction $X^{2+}{}_{(aq)} + 2e^- \longrightarrow X_{(s)}$ is

A. 2.15 V
B. 1.59 V
C. -1.59 V
D. -3.27 V

47. If the reduction potential for a reaction is -0.76 V, then the oxidation potential for the reaction is

A. -0.76 V
B. -0.24 V
C. $+0.24$ V
D. $+0.76$ V

48. Using a table of standard reduction potentials, it can be deduced that

A. $H^+_{(aq)}$ ions will spontaneously oxidize $Mg_{(s)}$ but not $Cu_{(s)}$
B. $H^+_{(aq)}$ ions have equal tendency to oxidize and to reduce
C. only oxidizing agents above H^+ have a tendency to reduce
D. only oxidizing agents above H^+ have a tendency to oxidize

49. The net potential for the reaction of aluminum metal with an acidified permanganate solution is

A. +3.15 V
B. +0.17 V
C. −0.17 V
D. −3.15 V

50. The net potential for the reaction

$Ce^{4+}_{(aq)} + Fe^{2+}_{(aq)} \longrightarrow Ce^{3+}_{(aq)} + Fe^{3+}_{(aq)}$ is 0.67 V.

The reduction potential for $Ce^{4+}_{(aq)} + e^- \longrightarrow Ce^{3+}_{(aq)}$ is

A. +1.44 V
B. +0.10 V
C. −0.10 V
D. −1.44 V

Use the following information to answer question 51.

$$L_{(s)} + e^- \longrightarrow L^-_{(aq)} \qquad E^\circ = 2.00 \text{ V}$$

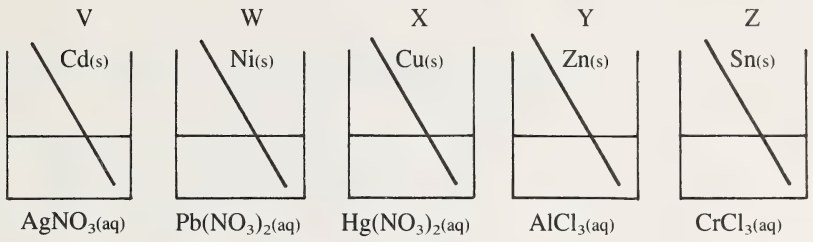
$$R^+_{(aq)} + e^- \longrightarrow R_{(s)} \qquad E^\circ = -2.00 \text{ V}$$

51. Which of the following statements is consistent with the information given?

A. $L_{(s)}$ will react spontaneously with $R^+_{(aq)}$.
B. $R_{(s)}$ will react spontaneously with $L^-_{(aq)}$.
C. $L_{(s)}$ is a strong oxidizing agent.
D. $R_{(s)}$ is a strong oxidizing agent.

Use the following information to answer question 52.

Strips of metals are placed in solutions as shown below.



52. Predict in which beakers spontaneous reactions would be observed.

A. W and Y
B. V, W, and X
C. V, X, and Y
D. W, Y, and Z

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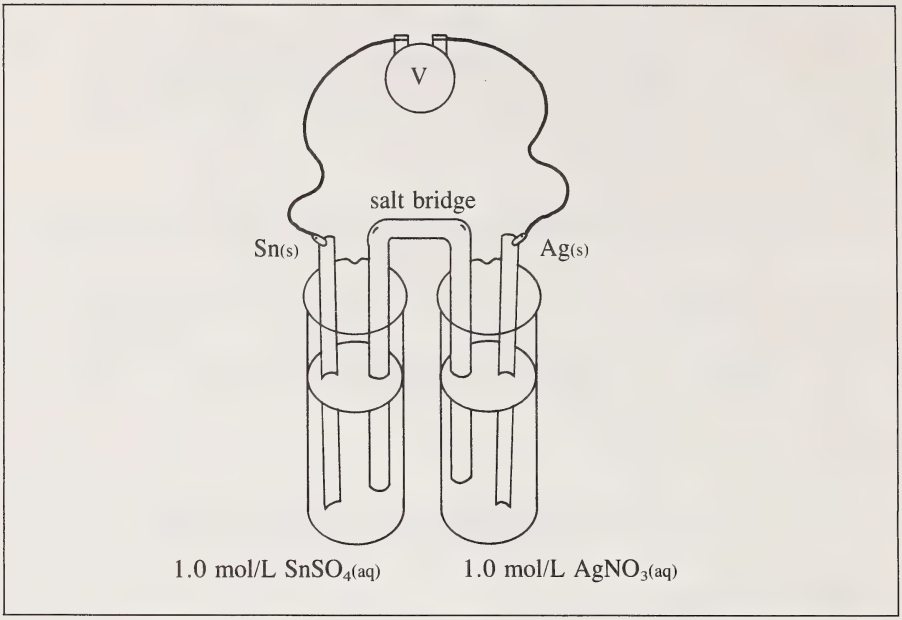
53. The E° of an iron-cobalt electrochemical cell containing $Fe(NO_3)_{2(aq)}$ and $Co(NO_3)_{2(aq)}$ is

A. -0.69 V
B. -0.13 V
C. $+0.13$ V
D. $+0.69$ V

Use the following information to answer question 54.



54. During the operation of the cell, the reaction at the anode is

A. $Sn^{2+}_{(aq)} + 2e^- \longrightarrow Sn_{(s)}$

B. $Sn_{(s)} \longrightarrow Sn^{2+}_{(aq)} + 2e^-$

C. $2Ag_{(s)} \longrightarrow 2Ag^{+}_{(aq)} + 2e^-$

D. $2Ag^{+}_{(aq)} + 2e^- \longrightarrow 2Ag_{(s)}$

55. In an electrolytic cell

A. reduction occurs at the anode
B. cations migrate toward the anode
C. cations migrate toward the cathode
D. a spontaneous redox reaction occurs

56. Magnesium blocks are often welded to ship's hulls to decrease the loss of iron from the hull due to rusting. The magnesium blocks would cause

A. magnesium to reduce in place of iron
B. iron to reduce in place of magnesium
C. magnesium to oxidize in place of iron
D. iron to oxidize in place of magnesium

YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.

PART B

INSTRUCTIONS

Please write your answers in the examination booklet as neatly as possible.

Show all pertinent calculations and formulas, and give your answers to the correct number of significant digits.

You may refer to your data booklet where appropriate.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

TOTAL MARKS: 14

START PART B IMMEDIATELY

Use the following information to answer question 1.

4.61 g of $HCOOH_{(l)}$ were completely burned to $CO_{2(g)}$ and $H_2O_{(l)}$ in a calorimeter, according to the equation:

$$HCOOH_{(l)} + \tfrac{1}{2}O_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(l)}$$

Initial temperature of calorimeter and calorimeter water = 21.5°C
Final temperature of calorimeter and calorimeter water = 29.4°C

3.20 kJ of energy are required to raise the temperature of the calorimeter and calorimeter water by 1.0°C.

(4 marks) **1.** Using the data above, calculate the heat of FORMATION of $HCOOH_{(l)}$.

Use the following information to answer question 2.

You are given four unlabelled beakers containing 0.100 mol/L solutions of LiOH, $Ba(OH)_2$, HNO_3, and H_2SO_4. Following is a laboratory procedure that would enable you to determine which solution is in each beaker:

I One to two drops of bromothymol blue are added to a sample of each of the four solutions. The colors are recorded.

II Equal volumes of the solutions identified as $HNO_{3(aq)}$ and $H_2SO_{4(aq)}$ are titrated with 0.100 mol/L $NaOH_{(aq)}$ using bromothymol blue as the indicator. The titrations are performed separately. The volumes of all solutions used in the experiment are recorded.

III Equal volumes of the solutions identified as $LiOH_{(aq)}$ and $Ba(OH)_{2(aq)}$ are titrated with 0.100 mol/L $HCl_{(aq)}$ using bromothymol blue as the indicator. The titrations in this step are also performed separately. The volumes of all solutions used in the experiment are recorded.

(5 marks) **2. a.** Describe the expected results for each of the three steps of the procedure. You may use diagrams where appropriate.

2. b. Explain how the results will identify each of the four solutions.

Use the following information to answer question 3.

The following materials are made available:

strip of chromium metal	voltmeter
nickel wire	connecting wires
$Cr_2(SO_4)_3$ crystals	porous cup
$NiCl_2$ crystals	glass U-tube
0.1 mol/L $KNO_{3(aq)}$ solution	cotton plugs for U-tube
distilled water	beakers of various sizes

(5 marks) **3. a.** Using as many of the above materials as required and ONLY the above materials, draw a diagram showing your design of a spontaneous electrochemical cell.
Be sure to label your illustration, including the materials used for the electrode and the electrolyte in each half-cell, the anode and the cathode, and the direction of flow of electrons.

3. b. Write the anode and cathode half-reactions.

3. c. Determine the experimental E^{o}_{net} for the cell, assuming the solutions used are 1.0 mol/L.

YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME, YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.

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FOR DEPARTMENT USE ONLY

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FOR DEPARTMENT USE ONLY

CHEMISTRY 30

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CHEMISTRY 30